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construction innovation

Surveys lead to better understanding of indoor climate in northern and coastal houses

As part of a project to develop durable, energy-efficient wall assemblies that can accommodate extreme outdoor and indoor climate conditions in northern and coastal regions, NRC-IRC researchers completed three field surveys of these conditions.

The researchers measured relative humidity (RH) and temperature (T) in eight houses in each of the three locations: Prince Rupert, BC; Inuvik, NT; and Carmacks, YT (see *Construction Innovation*, June 2005).

Summary of selected findings

Interestingly, some of the findings do not support the popular belief that the number of occupants and excessive moisture-generating activities are the main contributing factors to moisture problems.

- The houses with reported moisture problems did not experience systematically higher relative humidity indoors than those without moisture problems.
- The houses with the highest occupant loads did not experience more moisture problems or higher RH indoors than those with lower occupant loads.

Locations of the three surveys are indicated by the circles.

- In Prince Rupert (cool and humid climate), the average daily indoor RH in May 2005 ranged from 35 to 65%, while in Inuvik (very cold), the average daily indoor RH in the eight houses surveyed in November 2006 ranged from 10 to 30%. (This finding does not support the popular belief that northern houses tend to be very humid inside.)

Highlights

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This group of houses demonstrates the wide open spaces and absence of trees typical of northern housing.

Other noteworthy findings include:

- "Wet" rooms (bathrooms and kitchens) experienced peaks of RH that were higher than the average RH. Bathroom peaks reached 100% RH daily in all houses surveyed. Monitoring in other rooms indicated more stable and lower RH conditions.
- In the Carmacks survey, extreme indoor temperature fluctuations were a major contributing factor to moisture problems. Most of the

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Standing committees set priorities for the 2010 codes

The standing committees of the Canadian Commission on Building and Fire Codes (CCBFC) have finalized their workplans identifying tasks to be completed for the next edition of the National Construction Codes in 2010.

According to the standing committees' preliminary analysis, approximately thirty tasks—all identified as priorities by the CCBFC—will be completed by Spring 2008 in time for the Fall 2008 public review, the last step before the final CCBFC decisions regarding what gets included in the 2010 edition of the National Construction Codes. Some of these tasks that have been completed sooner will form the basis of the Fall 2007 public review. Standing committee plans with completion dates can be found at www.nationalcodes.ca/ccbfc/priorities_e.shtml.

The following two tasks—also identified as priorities by the CCBFC—could have an impact on the 2010 codes or future editions of the codes. These tasks are being worked on in parallel to the standing committees' priority tasks, in accordance with their workplans.

Impact Analysis

The CCBFC and the Provincial Territorial Policy Advisory Committee (PTPACC) have established a joint task group to develop a set of guidelines on impact assessments and cost-benefit analyses of changes proposed to the national codes and to the decision-making process used by the standing committees.

The form for requesting a code change requires that it be accompanied by an analysis of the cost implications of implementing the change. There is, however, no guidance for those requesting changes, nor to standing committees evaluating such requests, on the nature and extent of this information or on the decision-making process used.

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There are concerns that the lack of specific guidelines on information required to support a request for change may be a major obstacle to technical code development. There have been instances in the past where a proposed code change was withdrawn or delayed due to concern by a jurisdiction about possible cost implications and the lack of satisfactory information in this regard. With a clear framework for providing the required information, the instance of this outcome will be reduced. As well, the analysis will add clarity—in advance of public review—to the process for determining the specific parts of the requested change that are likely to have significant cost impacts.

Any questions related to this issue can be directed to Igor Oleszkiewicz at 613-991-4807, fax 613-952-4040, or e-mail igor.oleszkiewicz@nrc-cnrc.gc.ca.

Care and Residential Care Occupancies

The CCBFC and the PTPACC have also approved the formation of a Task Group on Care and Residential Care Occupancies. This task group has been given a high priority, as the jurisdictions wish to see provisions included in the 2010 National Construction Codes that address the concerns regarding this type of occupancy.

Care and Residential Care premises generally require more fire and structural safety features than those of a typical residential occupancy (i.e., Group C occupancy), but do not generally require these features to be as extensive as those of institutional occupancies, such as hospitals or nursing homes (i.e., Group B occupancy). Designers and owners are often burdened with the capital cost of meeting these higher Group B requirements, without substantial benefit to their clients or occupants.

As these care facilities are found across Canada, the CCBFC and PTPACC have indicated that considering ways to amend the model National Building Code and Fire Code (NBC and NFC) is among their priorities. This would involve addressing the issue of whether and how to establish a new occupancy classification and related Code requirements that adequately reflect the concerns related to these types of occupancies.

Any questions related to this issue can be directed to Philip Rizcallah at 613-993-9960, fax 613-952-4040, or e-mail philip.rizcallah@nrc-cnrc.gc.ca.

www.nationalcodes.ca

CCMC

New Evaluation Reports

Company	Product Name	CCMC #	Description
Emercor Ltd.	Emercor Insulated Rim Board	13254-R	"EMERCOR Insulated Rim Board" is composed of two sides of oriented strandboard (OSB) and lumber, top and bottom, to serve as a rim board around the perimeter of engineered wood joists.
Géopieux (90906173 Québec Inc.)	Geopile	13268-R	"Geopile" is an earth anchor constructed of helical-shaped, circular steel blades welded to a steel shaft, which functions as an auger-installed steel pile and is intended to be used as a foundation system.
Ashland Performance Materials	Isoset® UX-100/WD3-A322 & CX-47/WD3-A322	13267-R	"Isoset® UX-100/WD3-A322" is a polyurethane emulsion polymer (PEP) adhesive consisting of a polyurethane pre-polymer mixed with an emulsion polymer. It serves as a structural wood adhesive for the manufacture of engineered wood products in 'dry service' applications.
Weyerhaeuser	iLevel™ Rim Board	13261-R	"iLevel™ Rim Board" is manufactured from strands of a wood species, or a combination of species, blended with an isocyanate-based adhesive. It functions as a rim board around the perimeter of engineered wood joists.
Gerard Roofing Technologies Inc.	Gerard Shingle/Granite Ridge/ Guardian Shingle	13260-R	"Gerard Shingle/Granite Ridge/Guardian Shingle" panels are composites of metal, acrylic and stone chips designed to emulate traditional asphalt roofing products. They serve as a roofing system.
Gerard Roofing Technologies Inc.	Gerard Tile/Gerard Shake/ Stormtile/Canyon Shake	13258-R	"Gerard Tile/Gerard Shake/Stormtile/ Canyon Shake" panels are composites of metal, acrylic and mineral aggregates (no aggregates for "Canyon Shake") and serve as a roofing system.
Valéron Strength Films, an ITW Company	Valéron Vortec™/ WeatherTrek™ with Valéron EVD Technology	13259-R	"Valéron Vortec™/WeatherTrek™ with Valéron EVD Technology" is a perforated, cross-laminated polyethylene. The product is white and incorporates a surface pattern of non-directional channels that promotes wall drainage and serves as a breather-type sheathing membrane.

For further information on the performance, usage and limitations of these products, as well as for other reports and listings by CCMC, see the Web Registry of Product Evaluations located at **http://irc.nrc-cnrc.gc.ca/ccmc/regprodeval_e.html**.

Fire research

Fire Safety Research for Better Building Design

Building Science Insight 2007

This coming fall, NRC-IRC will be bringing you information on the latest research on fire safety to help you design better and safer buildings.

As part of the Institute's annual Building Science Insight seminar series, leading fire researchers will visit cities across Canada to present and discuss their recent research findings.

BSI 2007 will address fire-safety issues of particular importance to the construction industry, including design fires, smoke management and control, notification (i.e., the ways in which people become aware of a fire), occupant response and evacuation, and fire-suppression systems.

Additional information on this seminar series will be provided in the next issue of *Construction Innovation*.

Registration information:
Please contact Monique Myre at 613-993-0435, fax 613-952-7673, or e-mail monique.myre@nrc-cnrc.gc.ca.

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Surveys lead to better understanding of indoor climate in northern and coastal houses

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houses surveyed there were heated with a central wood stove without a heat-distribution system.

Next steps

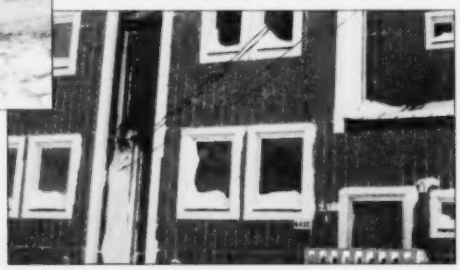
The monitoring of indoor RH and T in 24 houses with different characteristics (they varied widely in terms of their construction and occupant lifestyle) has proven instrumental to NRC-IRC researchers in their quest to identify realistic extreme indoor conditions. This information will provide the basis for the laboratory evaluation of the moisture control performance of wall assemblies that appear promising for houses in these climates.

The evaluation will involve subjecting the test wall specimens to indoor temperature fluctuations and short-term peaks of indoor RH at near saturation, while at the same time, extreme outdoor climatic conditions will prevail. The next challenge for the research team will be to determine the technical feasibility of implementing the test protocol in NRC-IRC's unique Envelope Environmental Exposure Facility.

For more information, please contact Madeleine Rousseau at madeleine.rousseau@nrc-cnrc.gc.ca and visit the project Web site at http://irc.nrc-cnrc.gc.ca/bes/hmpe/north60_e.html.

Project collaborators

Canada Mortgage and Housing Corporation
Natural Resources Canada
Program of Energy Research and Development (PERD)
The Sheltair Group
Arctic Energy Alliance
Prince Rupert Housing Corporation
Yukon Housing Corporation
Inuvik Housing Authority



Photos show the very fine snow projected by the wind onto walls and windows, a characteristic of houses in the north seen by the research team.

Features of the survey

- Continuous measurements of RH and T were made at three-minute intervals in two rooms of each house over a one-month period.
- Eight houses per region were selected in collaboration with local housing corporations.
- Houses varied with respect to age, air-leakage characteristics, occupancy loads, heating and ventilation systems, and energy efficiency.
- An NRCan Energuide for House audit and an air leakage test were conducted in each house.
- Four of the eight houses in each region were selected because they had reported moisture problems (e.g. condensation, mould growth, water damage on interior finishes).

Newsbrief

Roofing researchers to develop new test protocol for quantifying air leakage through low-slope roof assemblies

Increasing demand for and the rising cost of energy have intensified interest in the issue of air leakage through the building envelope. However, until recently, the roof—in contrast to walls and windows—has not received much attention regarding its air-leakage performance.

Being able to control air intrusion is critical in roofing design, as this has several effects on the performance of the roof—on wind uplift, energy consumption and moisture migration. Now, advances in roofing technology are providing greater opportunities to control air intrusion. But at present, there are no code requirements, standard specifications or test methods for the design or quantification of air-barrier performance in roofing assemblies.

NRC-IRC researchers are working to address these deficiencies. They have laid the groundwork by conducting a feasibility study, which included the creation of a small-scale test facility, and attempted to quantify the air-leakage rate of the roofing assembly both with and without an air barrier.

The preliminary results clearly demonstrated the significance of the barrier in providing air-leakage resistance. But because these observations were based on small-scale experiments, which were devoid of any joints, junctures or penetrations, it is clear that there is a need to build a full-scale air-leakage facility that replicates a real roof so that further research can be conducted.

NRC-IRC is seeking collaborators from both private and public sectors for this study to develop:

- a laboratory test protocol to quantify air leakage in roofs that could be used in the development of codes, standards and guidelines;
- design tools for air barrier systems in roofs;
- a field test protocol that provides comparable results to those of the laboratory test protocol;
- an analytical tool to predict changes in energy demand due to variations in the air-leakage characteristics of roof assemblies.

Specific questions can be directed to Dr. Sudhakar Molleti at 613-993-9673, fax 613-998-6802, or e-mail sudhakar.molleti@nrc-cnrc.gc.ca.

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http://irc.nrc-cnrc.gc.ca/pubs/index_e.html

There you can click your way to these free publications:

- *Construction Technology Updates* – These practical 4-6 page publications, part of a current series presenting applications of research results and reviews of building science issues. Currently 65 titles are available.
- *Registry of Product Evaluations* – The Registry contains all Evaluation Reports and Listings for products evaluated by NRC-IRC's Canadian Construction Materials Centre.
- *Seminar Publications* – A collection of publications and documentation from building science and construction technology seminars presented by NRC-IRC since 1982.
- *Canadian Building Digests* – This is a discontinued but still valuable series of 250 4-page publications containing scientific and technical principles and practical guidelines, published between 1960 and 1990.
- *Building Practice Notes* – This discontinued series of publications, issued between 1976 and 1986, contains results, explanations and guidelines on many building issues. Much of the information remains relevant today.
- *Guide for Sound Insulation in Wood Frame Construction:* comprehensive information on the control of flanking noise through wood-frame construction.

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These titles have live links, so you can quickly go to our Virtual Store for easy online ordering. In the Virtual Store, click on "Construction Publications," select the appropriate category on the left, then scroll down to the publication you want to order.

- *A Guide to the Wind Design of Mechanically Attached Flexible Membrane Roofs*
- *Air Barrier Systems for Walls of Low-rise Buildings: Performance and Assessment*
- *Protocols for Building Condition Assessment*
- *Building Science for a Cold Climate*
- *Productivity in Construction*
- *IBANA-Calc User's Manual*
- *Managing Indoor Air Quality: A Manual for Property Managers*
- *Controlling Indoor Air Quality: Ventilation Engineering Guide*
- *Maintaining Indoor Air Quality Through the Use of HVAC Systems*
- *Manual for Screening of Buildings for Seismic Investigation*
- *Guidelines for Seismic Evaluation of Existing Buildings*
- *Guideline for Seismic Upgrading of Building Structures*
- *Guidelines for Condition Assessment and Rehabilitation of Large Sewers*
- *Effective Sealing of Pavement Cracks in Cold Urban Conditions*
- *Durability and Performance of Gravity Pipes: A State-of-the-Art Literature Review*
- *Durability and Performance of Gravity Pipes: State of Current Practice*
- *Deterioration of Concrete: Symptoms, Causes and Investigation*

For assistance, call 1-800-672-7990 or 1-613-993-2463 (Ottawa-Gatineau and U.S.)

Newsbrief

NRC-IRC researchers study mould growth in buildings

The presence of mould in buildings can affect the health of occupants and the durability of building components, a problem that can occur anywhere in Canada in any type of occupancy. Contributing factors include external and internal climate loads, the characteristics of the building materials, the design and detailing of assemblies, and the design and operation of HVAC systems.

To address the issue of mould in buildings, NRC-IRC researchers have initiated a five-year mould research project to develop reliable and effective tools in three areas:

- *Mould-detection techniques*
  Current challenges include detecting moulds in concealed spaces, such as ventilation ducts and wall cavities, without incurring expensive and disruptive demolition.
- *Likelihood of mould growth on building materials and components*
  Research will focus on the laboratory assessment of the resistance to mould growth of building materials, components and full-scale assemblies, as well as on numerical modelling to predict the possibility of mould growth in various situations.
- *Remediation methods*
  This research will build on the first two areas and will help define the extent of remediation work (using reliable detection techniques) and the best practices required to minimize the re-occurrence of mould growth in refurbished buildings.

In this project, the researchers will concentrate their expertise in moisture management, mould detection, hygrothermal characterization of building materials and assemblies, and HVAC systems to provide guidance to the building industry. New state-of-the-art laboratories for mould identification, quantification and assessment of the mould resistance of building assemblies are currently under construction and will be ready to accommodate this project in 2007.

As tackling the issue of mould in buildings requires a multi-disciplinary approach, NRC-IRC is seeking partners from both private and public sectors to continue its work in the three areas of research described above. For more information, please contact Dr. Hans Schleibinger at hans.schleibinger@nrc-cnrc.gc.ca.

Project to provide risk-based life-cycle management of aging highway bridge decks

Highway bridges are critical links in Canada's transportation network. The reinforced concrete deck slab is the bridge component most directly exposed to traffic and de-icing salts, which result in corrosion—the major cause of deterioration of deck slabs in North America. This deterioration is exacerbated by ever increasing traffic volume and greater loads.

These aging and deteriorated structures require costly maintenance, rehabilitation and replacement, with about one-third to one-half of their projected rehabilitation costs related to deterioration of the deck. The consequences of deterioration and failure include loss of serviceability and functionality, reduced safety, shortened service life, and increased costs to owners and users.

Owners need decision-support tools to help them manage their bridges and ensure that the risk of failure is kept at an acceptably low level throughout the life of a bridge. An effective bridge-management system should provide: (i) qualitative and quantitative performance indicators of the bridge deck over its life cycle; (ii) identification of critical decks that need to be scheduled for detailed inspection, maintenance, rehabilitation and renewal for each year of the life cycle; and (iii) an evaluation of the life-cycle costs of all feasible design and maintenance alternatives to select the most cost-effective options.

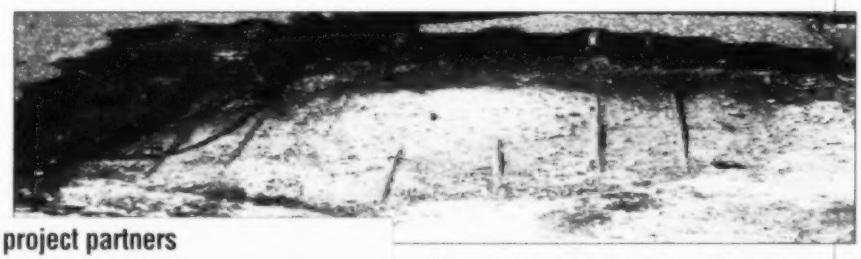
To assist owners and engineers in addressing these challenges, researchers at NRC-IRC developed analytical models that can predict the deterioration of bridge decks and their life-cycle costs. The life-cycle cost-analysis model evaluates and compares the agency and user costs associated with the design, construction, inspection, maintenance, rehabilitation and replacement of different options over the specified life cycle. The researchers integrated these models into a prototype decision-support software, *SLAB-D*, which provides owners with a tool for selecting cost-effective options. Currently, this prototype software is available only to project participants.

At present, highway agencies rely heavily on qualitative indicators of performance obtained from visual inspection and non-destructive evaluation to manage their bridge decks. The use of such simple models is practical and inexpensive. However, such models can be quite subjective and do not provide a quantitative measure of the risk of failure.

To address these limitations, the researchers are planning to launch a new project in April 2007, which will focus on the development of qualitative performance prediction models and their integration with the quantitative models of *SLAB-D* to create a comprehensive bridge-deck management system. The qualitative deterioration model will be based on cumulative damage theory, and will be used to provide estimates of the life-cycle performance of a deck, or a network of decks, as well as long-term estimates of maintenance funding needs.

The integration of the two types of deterioration model will improve the reliability of the performance predictions and enable optimization of the inspection and maintenance processes. And the incorporation of these deterioration models and a life-cycle cost analysis model into a total management system will allow owners to prioritize projects and select cost-effective maintenance strategies, which will in turn extend the service life and keep the failure risk of bridge decks at acceptable levels.

For more information about this project, or to become a partner, please contact Dr. Zoubir Lounis at 613-993-5412, fax 613-952-8102, or e-mail zoubir.lounis@nrc-cnrc.gc.ca. You can also visit http://irc.nrc-cnrc.gc.ca/ui/cs/decisionsupport_e.html or http://irc.nrc-cnrc.gc.ca/ui/cs/lifecycle_e.html.



Corrosion of the reinforcing steel causes significant damage to the bridge deck slab.

SLAB-D project partners

Alberta Infrastructure and Transportation
Cement Association of Canada
City of Hamilton
City of Ottawa
City of Winnipeg
Engineered Management Systems Inc.
Federal Bridge Corporation Ltd.
Manitoba Department of Transportation and Government Services
Ministère des Transports du Québec
Nova Scotia Transportation and Public Works
Public Works and Government Services Canada
Regional Municipality of Durham

Lighting scientists and designers exchange information about lighting and health

The 2nd CIE Symposium on Lighting and Health was held in Ottawa in September 2006, providing a wealth of new information on the effects of light on health and the implications for practical lighting design. Some highlights from the presentations included:

circadian rhythm: one's 24-hour biological cycle
circadian phase-shifting: the overall pattern (circadian rhythm) remains the same although the peaks of the cycle occur at different times.
colour temperature: this property is a function of the various wavelengths comprising the light source.

Lighting for jet lag and shift work
Resetting a maladjusted circadian rhythm—such as one experiences when flying across time zones or working a night shift—can be achieved with intermittent bursts of 20-minute exposure to 1200-lux white light, provided that the exposures are properly timed and the worker avoids light exposure during non-working hours. This information represents an important advance because the solution does not require energy-intensive additions to room lighting, contrary to what was previously thought.

Lighting for well-being
NRC-IRC's Dr. Jennifer Veitch reviewed research from the U.S. and Finland suggesting that well-being could be enhanced by increasing the amount of light to which people are exposed on a daily basis. Thus far, it appears that the lighting increases might not need to be very large, nor constant.

Cancer risk from light at night
It is known that night-shift workers face an elevated risk of breast cancer, and animal studies have shown that light exposure at night can speed tumour growth. At the symposium, attendees learned about a test of the hypothesis that light at night increases human breast cancer risk by reducing levels of the hormone melatonin. The pattern of results suggests that disrupted melatonin rhythms are a significant risk factor for human breast cancer, and possibly other cancers. From a practical perspective, this means that healthy lighting includes healthy darkness. Experts advise that one sleep in a dark room, using light-excluding window coverings, and direct lights away from neighbours' windows.

New lighting technologies
One paper addressed a possible treatment for night restlessness experienced by Alzheimer patients, which is a serious problem for patients and caregivers alike. Exposure in the late afternoon or evening to bright blue light from light-emitting diodes (LEDs), as compared to dim red LED light, reduced the frequency of patients' early-morning waking. Another presentation described a dynamic lighting system that changes both in intensity and colour temperature throughout the workday, in response to visual, circadian and energy-efficiency requirements.

Industry leaders' perspectives
Industry leaders summarized their views on practical applications. The central theme of these comments was the connection between healthy lighting and sustainability. In fact, the research findings point most strongly to the role of good daylighting in providing healthy lighting, which offers additional justification—on top of sustainability—for investment in daylighting.

The symposium speakers and discussions identified many areas for new research and its application. For their part, lighting researchers in NRC-IRC's Indoor Environment program are developing new research projects, building on work presented at the symposium. For more information, please contact Dr. Jennifer Veitch at 613-993-9671, fax 613-954-3733, or e-mail jennifer.veitch@nrc-cnrc.gc.ca.

Further information about the symposium is available at: http://irc.nrc-cnrc.gc.ca/ie/lighting/health/cie_e.html.

The Symposium was co-hosted by
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- Philips
- GE
- Osram Sylvania
- VELUX
- Zumtobel
- Canlyte

Finnish construction industry seeks innovative approaches

In October 2006, representatives of the Canadian construction industry met with a delegation from the Confederation of Finnish Construction Industries. This meeting was jointly hosted by the Canadian Construction Innovation Council (CCIC) and NRC-IRC. While the Finnish delegation's principal interest was infrastructure, the discussion covered many topics, including the differences and similarities of the Finnish and Canadian industries regarding the drivers and barriers to innovation. Meeting highlights are as follows:

Although smaller in size, the Finnish industry has much in common with the Canadian industry: it is a significant component of the economy; it represents about 6 per cent of the total work force; and it, too, is an industry comprised primarily of small- to medium-sized enterprises that faces the difficulties of an aging workforce, relatively low labour productivity, and the slow adoption of innovation.

However, there are some significant differences between the two countries. In Finland, there are only two levels of government (federal and municipal) and the entire construction industry is represented by a single organization, the Confederation of Finnish Construction Industries, which represents contractors (general and speciality), product providers and designers, and also deals with labour issues. This single voice is viewed as having provided the Finnish industry with enhanced access to, and collaborative opportunities with, the two levels of government.

In addition, the Finnish government is known to be interested in alternative approaches that foster innovation. One such approach has been to offer longer-term contracts (10 to 15 years) for the provision of construction, operation and maintenance of all highways within a given geographical sector. The successful bidder must introduce innovative solutions that have an impact on all aspects of that highway system. At the end of the contract period, the facility is returned to the government at a pre-established service level.

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In other instances, pilot projects are awarded based on the degree of innovation demonstrated in the proposal. The benefits derived from the innovation are shared according to a negotiated ratio between the proponent and the owner. In this case, it is the proponent who takes the risk, the expectation being that he/she has confidence in the success of the proposed innovation. This approach is intended to redress the perceived imbalance between risk and reward that characterizes traditional projects.

Finland is also making strategic investments in the development of information technology to streamline data collection and data entry activities—similar to Norway's ByggSøk initiative (see *Construction Innovation*, March 2006)—with the intent of establishing a data model protocol that supports all design and construction work. As such, data only need be entered once and can then be shared for the planning, design, construction and maintenance phases, thus facilitating 3-D visualization, automatic preparation of as-built drawings and models, and the automation of certain processes on the construction site.

The Finnish model of industry/government cooperation through a simplified and unified relationship appears to offer a high level of innovation related to both technology and process. Canada should continue to monitor and learn from the Finnish experience, as well as from the experiences of other countries.

For more information, please contact Gerry Meade, CCIC, at gmeade@rogers.com, or visit the Confederation of Finnish Construction Industries Web site at http://www.rakennusteollisuus.fi/english/.

Possible breakthrough in earthquake-resistant timber construction

Earthquakes last only seconds, but their shockwaves can be felt for many years in lost lives and property damage. To help lessen these effects, researchers from the University of Canterbury in Christchurch, New Zealand, recently outlined an extensive research program to develop new structural systems and connections for multi-storey laminated veneer timber buildings in earthquake-prone areas. If successful, they believe these connections will allow timber buildings to survive and remain serviceable after earthquakes, reducing death tolls as well as repair and business interruption costs.

The Canterbury researchers outlined their program in a paper presented at the World Conference on Timber Engineering (WCTE) in August 2006. They will concentrate on innovative jointed ductile timber connections that are conceptually similar to post-tensioned precast concrete building systems. Researchers at the University of California developed these precast concrete systems and extended them to steel construction.

In the Canterbury system, the connections join prefabricated structural timber elements using unbonded post-tensioning so that the opening and closing of an existing gap accommodates seismic demand during an earthquake. This design keeps the structural elements in the elastic range and limits residual damage following a seismic event. The benefits of the design become particularly apparent when compared with the performance of "monolithic" structural systems, such as cast-in-place reinforced concrete, welded or bolted steel construction, or fully bolted, nailed or glued timber construction.

The researchers obtained further improved performance by combining the self-centering properties of the unbonded tendons with energy dissipation devices that are replaced after seismic events.

To test the connections, the researchers have applied the design concepts to two-dimensional and three-dimensional frames, structural walls and dual systems (coupled frame and wall systems). In addition, they have compared the response of these innovative systems with the response of solutions using monolithic construction.

Preliminary experimental results confirm the enhanced performance of the jointed ductile connections. Under different simulated earthquake situations, the tested systems show high levels of ductility, negligible residual deformations and no significant damage to the structural elements. Based on these very promising results, the researchers are pursuing further refinements in the tendon design, shear keys and energy dissipaters.

For more information, see "Innovative Seismic Solutions for Multi-Storey Timber Buildings," A. Palermo et al, 2006 World Conference on Timber Engineering.

Europe is taking steps toward achieving a sustainable and competitive construction sector

The European Construction Technology Platform (ECTP) has recently published its *Strategic Research Agenda for the European Construction Sector: Achieving a Sustainable and Competitive Construction Sector by 2030.*

Technology Platforms are a mechanism established by the European Commission to define research and development priorities, time frames and action plans for a number of strategically important industrial sectors, and are influential in the development of European research policy. The Platforms are a means to ensure that European industry remains competitive through increased investment in research, specialization in high technology, coordination across Europe, and by increasing the technological content of industrial activity.

The ECTP applies this approach to the European construction industry by setting forth three main themes for future construction research: meeting client/user requirements, becoming sustainable, and transforming the construction sector. Centred around these themes are thirteen strategic research priorities, such as healthy, safe and accessible indoor environments, value-added construction materials, and the improvement of safety and security.

The *Strategic Research Agenda for the European Construction Sector* provides us with a thought-provoking view of the long-term future of our industry in a society with which Canada has much in common. It is available from the ECTP Web site at http://www.ectp.org/documentation.asp.

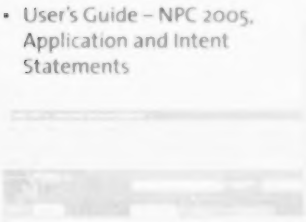
2005 NATIONAL CONSTRUCTION CODES & GUIDES

Now Available on CD-ROM!

The 2005 National Construction Codes and Guides CD-ROM contains the following publications, each of which is controlled by a convenient unlocking mechanism:

- National Building Code of Canada 2005
- National Fire Code of Canada 2005
- National Plumbing Code of Canada 2005
- User's Guide – NBC 2005, Application and Intent Statements
- User's Guide – NFC 2005, Application and Intent Statements
- User's Guide – NPC 2005, Application and Intent Statements

The **CD-ROM version of the 2005 National Building, Fire and Plumbing Codes** includes the Code provisions, which are linked to **application statements** (detailed statements on what the provisions apply to) and **intent statements** (detailed statements on the specific intent of the provisions). The Code provisions are also linked to **objectives** (statements that describe the overall goals that the Code provisions are intended to achieve) and to **functional statements** (statements that describe conditions that help satisfy the objectives).



Sample User's Guide interface

Sample Code interface

Main Features – Codes

- Links allowing easy navigation between various Parts of the Codes
- Instant links to cross-references, defined terms, Appendix Notes, etc.
- Powerful, easy-to-use search engine
- Changes to the 1995 editions of the Codes displayed on colored background
- Automatic updating with revisions to the 2005 Codes

The User's Guides to the 2005 National Building, Fire and Plumbing Codes contain the **application and intent statements** applicable to the Code provisions. **They do not include the Code provisions: the User's Guides are published as a complement to the printed versions of the Codes.**

Main Features – User's Guides

- Application and intent statements available from drilled-down table of contents
- Instant links to definition of terms, objectives and functional statements
- Powerful, easy-to-use search engine

Hardware Requirements (only available for Microsoft Windows)

- Pentium II processor running at 366 MHz or higher
- 128 MB RAM
- CD or DVD drive
- NIC or modem for receiving updates
- At least 500 MB of free disk space
- SVGA monitor (1024 x 768) with 16-bit colour

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new **National Building Code 2005**	$200		$190		$350**		$1,400		$2,100	
new **National Fire Code 2005**	$140		$130		$250**		$1,000		$1,500	
new **National Plumbing Code 2005**	$120		$110		$180**		$720		$1,080	
Practical 2005 NBC User's Guides: new Structural Commentaries (Part 4)	n/a***		$94							
new User's Guide – NBC 2005, Application and Intent Statements	n/a		n/a		$150		$600		$900	
Practical 2005 NFC User's Guide: new User's Guide – NFC 2005, Application and Intent Statements	n/a		n/a		$110		$440		$660	
Practical 2005 NPC User's Guide: new User's Guide – NPC 2005, Application and Intent Statements	n/a		n/a		$60		$240		$360	
Quebec Construction Code 2001	$120		$110		$179****		$715		$1,073	
National Farm Building Code 1995	n/a		$34		$51****		$204		$306	
Alberta Building Code 1997 on CD	n/a		n/a		$149****		$596		$894	
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* 1995 editions also available
** Includes application and intent statements
*** n/a = not applicable
**** Network pack of 1-2 users also available

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Upcoming events

APRIL

9-12
FIATECH Annual Technology Conference and Showcase. Washington, DC. http://www.fiatech.org/conferences/07/conf07obj.html

16-17
International Winter Construction Symposium and Expo. Edmonton. http://www.alberta-canada.com/chempet/eventDisplay.cfm?id=1356

23-25
First International Tunnel and Safety Forum for Road and Rail. Nice, France. http://www.tmi-intelligence.com/conferences.asp

23-25
Building Officials Association of British Columbia (BOABC) Annual General Meeting and Conference. www.boabc.org

25-27
4th International Conference on Traffic and Safety in Road Tunnels. Hamburg, Germany. http://www.tunnelkongress.de/index.php?lang=en

MAY

Building Science Insight
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www.bsi.gc.ca
Seminar series
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Infrastructures durables : Techniques, outils et guides
(Remaining seminars in French only)

May 11
Ste. Foy – Hôtel Classique
2815 Laurier Boulevard
Québec, QC G1V 4H3
Tel: 1-800-463-1885

May 17
Montreal – Holiday Inn Montréal-Midtown
420 Sherbrooke St. W
Montreal, QC H3A 1B4
Tel: 514-842-6111

We have reserved a block of rooms for your convenience. To reserve your room please call 418-658-2793 or 800-463-1885 and mention "National Research Council, Folio # 62220."

22-24
Third International Conference on Durability & Field Applications of Fiber Reinforced Polymer (FRP) Composites for Construction. Quebec City. http://www.civil.usherbrooke.ca/cdcc2007

31-June 7
SB07 Regional Sustainable Building Conference. Toronto. www.sb07toronto.org

JUNE

3-6
10th North American Masonry Conference. St. Louis, MO. www.masonrysociety.org/NAMC/index.html

3-7
21st Canadian Congress of Applied Mechanics (CANCAM 2007). Toronto. http://www.ryerson.ca/cancam07/MainEng2.htm

6-9
Canadian Society for Civil Engineering Annual General Meeting and Conference. Yellowknife, NT. http://www.csce2007.ca/

JULY

08-13
12th International Congress on the Chemistry of Cement. Montreal. www.ICCC2007.org

SEPTEMBER

4-5
CISBAT 2007. Renewables in a Changing Climate – Innovation in the Built Environment. Lausanne, Switzerland. http://cisbat.epfl.ch

This calendar does not include all events scheduled to take place during this time frame. For a more complete listing, see the Web version of "Upcoming events" at http://irc.nrc-cnrc.gc.ca/events_e.html

construction innovation

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